

Blimps as Research Platforms



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Purpose of this Talk

To explore the use of a blimp for atmospheric research

Outline

- General operating parameters for a blimp
- Scientific motivation: A modeler's point of view
- Blimps for process-oriented studies
- Potential applications and a specific example
- Previous studies with blimps
- Blimp options, costs, logistics, etc.
- Aircraft + Blimp synergism
- Other potential benefits

General Operating Parameters

- **Weather:** Calm and clear. BL clouds, light rain **OK**.
Snow and icy conditions, thunderstorm **not OK**.
- **Winds:** max 22 mph at take-off. Survive 90 mph while moored.
- **Flight Rules:** VFR day or night. IFR also possible
- **Locations:** Urban, rural and remote with FAA permission
- **Air Speed:** 10 - 50 mph
- **Payload:** 1000 - 4000 lbs (includes fuel, crew and equipment)
- **Altitude:** 200 - 8000 ft msl (depends on payload and FAA)
- **Endurance:** 7 - 12 hrs (depends on speed, payload & altitude)
- **Range:** 100 - 400 miles (depends on the factors above)

A Blimp flying over the Sydney Harbor in partly cloudy conditions



Scientific Motivation

There is a clear need to:

- Better understand chemical and physical processes at different scales
- Develop, evaluate and improve process models
- Reduce uncertainties of these process modules embedded in 3-D Eulerian models

Modeler's Point of View

There is a clear need for:

- Observing **spatial evolution** of chemical, physical and meteorological variables at surface and aloft
- Observing **temporal evolution** of these variables in a **Lagrangian** sense: **Tracking air mass history**

Current Approaches

- Surface stations
 - Temporal evolution at fixed points
 - Useful for Eulerian model evaluation
- Fixed-wing aircrafts
 - Large-scale spatial distributions aloft
 - High altitude vertical profiling
 - Data useful for Eulerian model evaluation, but
 - Difficult to interpret for process studies

There is a clear need for a platform for Lagrangian type measurements for process-oriented studies

Blimps for Process-oriented Studies

A blimp would be more suitable for:

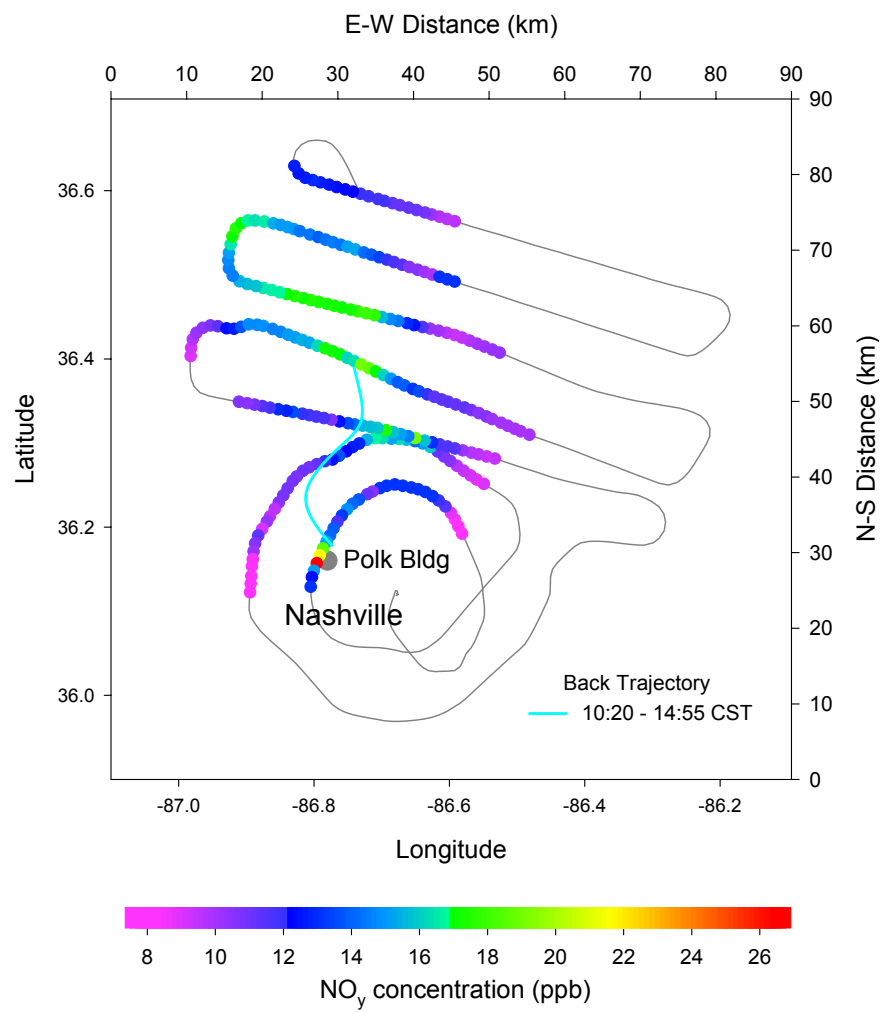
- Time evolution observations in an air mass:
Lagrangian or semi-Lagrangian measurements
- Stationary measurements aloft for 8-10 hrs:
"Portable tower"
- Evolution of vertical profiles downwind of localized sources,
e.g., in urban and power plant plumes
- Measurements where low-speed minimizes sampling errors: better signal/noise ratios

Potential Applications

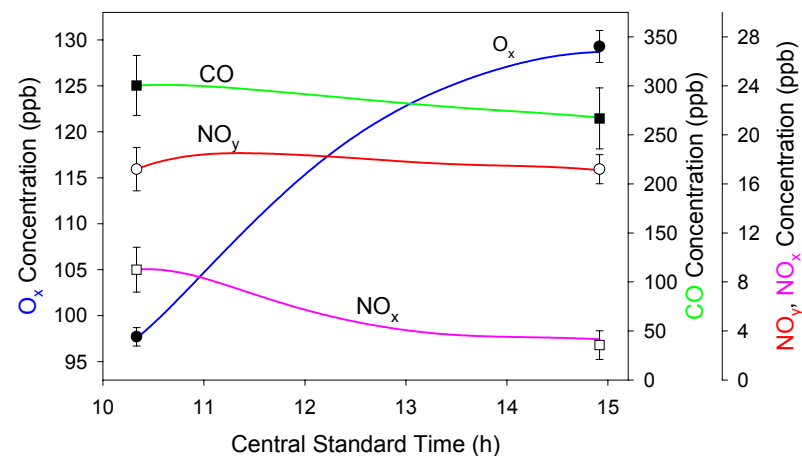
- **Chemistry**
 - Lagrangian evolution of trace gases and aerosols in an air mass
 - Diel cycles of trace gases and aerosols aloft over fixed locations
 - Lagrangian observation of aerosol nucleation and their precursors
- **Meteorology**
 - Dispersion studies using PFT tracers
 - Vertical fluxes of momentum, heat and moisture
 - High-res vertical mixing, turbulence and Eddy correlation studies
- **Climate**
 - Radiation measurements above and below clouds
 - Lagrangian observation of interaction of aerosols and clouds
 - Vertical profiles of aerosols and radiation
- **Emissions**
 - Development and verification of emission inventories
- **Instruments**
 - Use measurement techniques that take advantage of slow speed and low turbulence

A Specific Example: Nashville 99

G-1: Spatial Snap-shot



Lagrangian Box Model



Lagrangian measurements along the Trajectory with a blimp can help evaluate the model more effectively

Previous Studies with Blimps

Institute: Naval Research Laboratory

Lead Scientist: Bill Hoppel

Location: MBL, off Oregon coast

Years: 1992 and 1994.

Instrument Suite:

- SO_2 , NH_3 , O_3 , NO_x , H_2O_2
- DMA, PMS OPC, TSI CPC
- 3-wavelength nephelometer
- Cloud liquid water
- Aethalometer (BC)
- UV radiometer
- GPS

Key Observations:

- Cloud processing of aerosols
- Effects of ship aerosols on cloud droplet spectra
- Evidence of new particle formation

Institute: Univ. of Washington

Lead Scientist: Bill Plant

Location: MBL, off Oregon coast

Years: 1992 and 1993.

Instrument Suite:

- Sonic anemometer
- Fast humidity sensor
- Laser altimeter
- IR imaging system

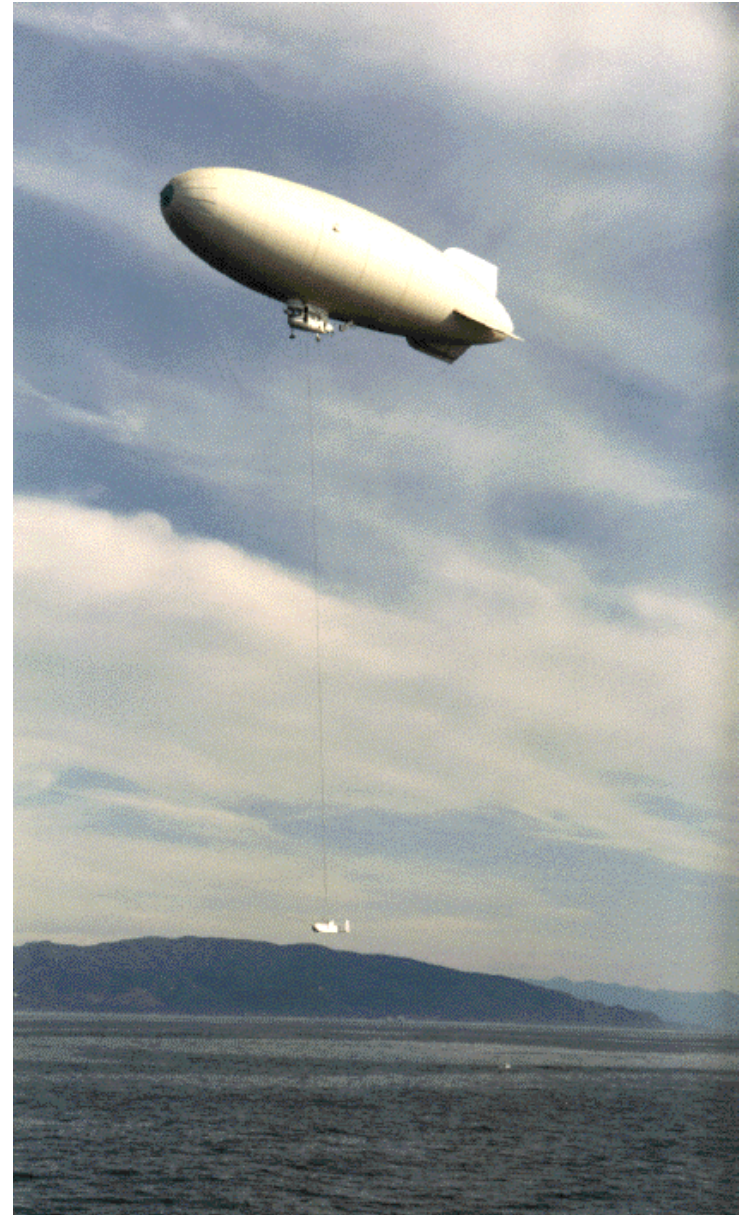
Key Observations:

- Atmospheric fluxes
- Microwave cross sections
- Doppler characteristics
- Turbulence
- Air and sea surface temps
- Wave heights

NRL



Univ. of Washington



References

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Hoppel et al., 1994: Marine boundary layer measurements of new particle formation and the effects non-precipitating clouds have on aerosol size distribution, J. Geophys. Res., **99**, 14,443 - 14,459.

Frick G.M. and W.A. Hoppel, 2000: Airship measurements of ship's exhaust plumes and their effect on marine boundary layer clouds, J. Atmos. Sci., **57**, 2625 - 2648.

Plant et. al., 1998: Measurements of the marine boundary layer from an airship, J. Atmos. Ocean. Tech., **15**, 1433-1458.

Plant et. al., 1999: Air/sea momentum transfer and the microwave cross section of the sea, J. Geophys. Res., **104**, 11,173-11,191.

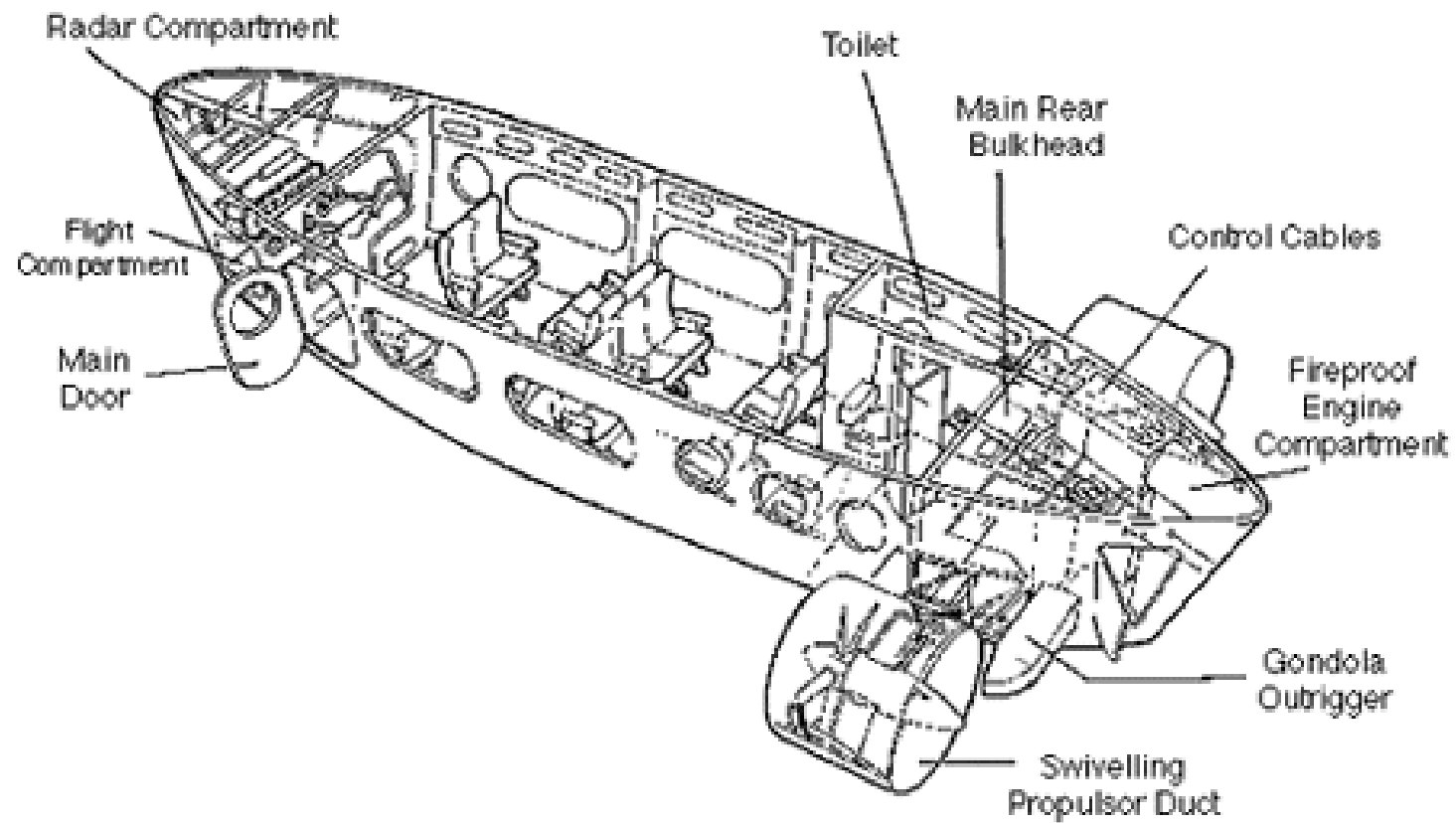
Hesany et al., 2000: The normalized radar cross section of the sea at 10 degrees incidence, IEEE Trans. Geosci. and Rem. Sens., **38**, 64-72.

Blimp Options

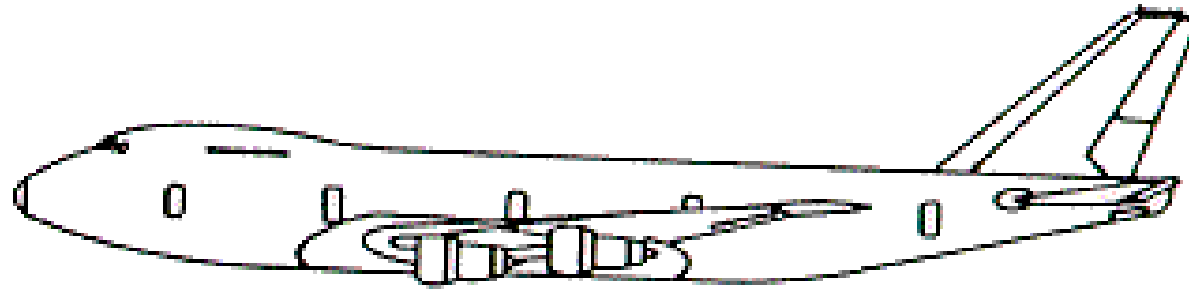
Feature	US-LTA, Oregon	American Blimp, FL	Global Skyships, FL	Fixed-wing Aircraft
Model	138S	A-150	SK-600	G-1
Payload @2K ft (lbs)	3000	3000	4000	4000
Cabin Space (sq ft)	70	70	190	165
Power (Watts)	2000*	2500*	1300*	8000
Cruising Speed (mph)	40	45	40	230
Endurance (hr)	8-10	8-10	8-10	4-5
Approx Month Lease (100 - 120 hrs)	~\$250K	~\$250K	~\$325K	~\$500K

*8 KW or more with a gasoline powered generator

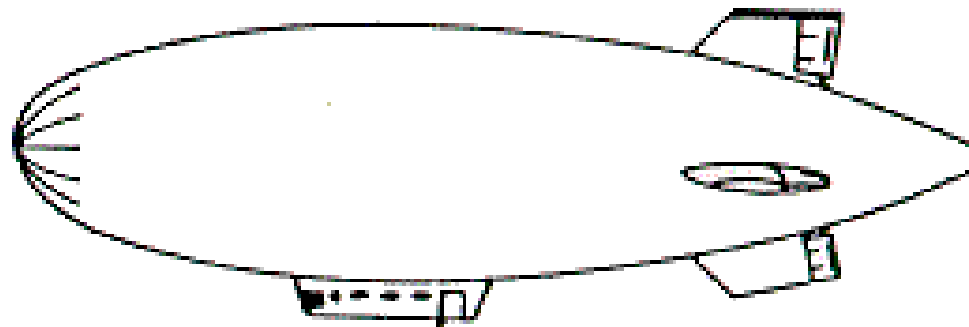
SK600 Gondola



Skyship 600 Size



Boeing 747
231'



Skyship 600
197.1'



Blimps and FAA Regulations

- Same as fixed-wing aircraft for cabin modifications (337)
- FAA usually assigns airspace for blimp operation in urban areas
- Fewer FAA restrictions outside urban areas
- Blimp companies have a good relationship with FAA. They can get approval for special missions
- Blimps are increasingly used for
 - Police patrolling (Atlanta PD)
 - Border surveillance
 - Maritime surveillance
 - Wildlife tracking
 - Advertisements



Other Potential Benefits

- High public visibility for ASP research during field campaigns
- DOE could advertise its research on air quality and climate change on the blimp
- Partner with corporations that are willing to **subsidize the lease**. They can advertise on the blimp and also get more publicity by associating themselves with environmental research



Aircraft + Blimp Synergism

- Aircraft
 - Spatial distribution of pollutants
 - High altitude vertical profiles
 - Short duration, large distances
 - Spatial surveys and long-range transport studies
- Blimp
 - Time evolution of pollutants
 - Low altitude vertical profiles
 - Long duration, short distances
 - Process-oriented studies
- Result: Unique, high-quality datasets
 - Provide deeper insight into spatial and temporal behavior of pollutants
 - Allow more rigorous evaluation of process models
 - Reduce uncertainties in 3-D models

Summary

- A blimp is the platform of choice for process-oriented studies for which geographical coverage and altitude range are not of major concern
- There is a potential for synergism between aircraft and blimp
- Unique spatial and temporal observations would substantially advance the science of air pollution and climate change
- Help DOE carve a niche in process-oriented atmospheric studies
- Economics for a blimp operation appear to be favorable
- Blimps have strong visual presence. An ideal platform for advertising DOE's efforts on air quality and climate research